Irregular working hours in the airline industry

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SUMMARY

In Europe and the US, about 19% of the workforce has to work during the night, while 17% is involved in schedules with permanent or rotating shift schedules. These irregular working hours disturb the circadian rhythm and sleep/wake pattern of the workers, and can interfere with their social life and work-family balance. On the short-term, irregular working hours have been shown to lead to fatigue, sleep loss, and digestive disturbances. More chronic health effects include gastrointestinal, reproductive, metabolic and cardiovascular disorders. Both short- and long-term health effects are thought to be determined by a combination of factors: work schedule characteristics and working conditions (working situation); familial and social responsibilities (factors outside work); and personal characteristics, physical and mental fitness, coping strategies and lifestyle (workers' capacity) (**Chapter 1**).

Research with company databases, containing objective data on work-related and individual factors, might further clarify the association between specific work schedules and health outcomes. In addition, it should be determined if especially developed interventions are able to support employees involved in irregular working hours. This would be of special interest for airline companies who have to operate 24 hours a day. A large part of their employees are exposed to a variety of irregular working hours and/or time zone crossings, possibly contributing to an increased sickness absence, and a loss in productivity. The first objective of this thesis was therefore to better determine the health effects of exposure to irregular working hours in the airline industry, by investigating the associations between cumulative exposure to irregular working hours and adverse work-related health outcomes, such as sickness absence and occupational accidents, within an airline company. The second objective was to increase the workers' capacity and reduce the impact of exposure to irregular working hours, by developing and evaluating an intervention aimed at reducing fatigue, and improving the health-related behaviour of airline pilots.

In the first section of this thesis, the current status of the scientific literature regarding the association between exposure to irregular working hours and two health outcomes were summarized. **Chapter 2** presented a systematic review in which the available evidence for an association between shift work including night shifts and body weight change was analyzed. A systematic search strategy was performed on longitudinal studies, after which the methodological quality was assessed by a standardized quality checklist, and the results were summarized using a levels of evidence synthesis. The results showed that there was strong evidence for a crude relationship between exposure to several types of shift work and an increase in body weight. This evidence proved to be insufficient when health-related confounders such as age, gender, body weight and physical activity were taken into account. These findings implicate that altered health-related factors, which could be the result of working irregularly, influence the association between exposure to irregular working hours and body weight gain.

In **Chapter 3**, we systematically reviewed the literature to clarify the association between exposure to irregular working hours and sickness absence. A systematic search strategy on observational studies was performed after which the selected relevant articles were scored on methodological quality. The studies were categorized according to shift work characteristics and summarized using the levels of evidence synthesis. Due to inconsistent findings, there was no evidence for an association between different types of shift work and sickness absence. Evidence was found for an association between fixed evening shifts and long-term sickness absence in female healthcare workers. These findings imply that the association between exposure to irregular working hours and sickness absence depends on both the work schedule and the studied working population.

In the second section of this thesis, we analyzed the MORE (Monitoring Occupational Health Risks in Employees) cohort, a five-year historic cohort consisting of all workers employed at an internationally operating airline company at January 1, 2010. The cohort data comprised all work and human resource records of the employees since January 1, 2005, combined with sickness absence and occupational accident data, provided by the occupational health service of the airline company. **Chapter 4** described a study that involved the ground staff employees of the MORE cohort, analyzing the association between cumulative exposure to different types of shift schedules, the number of night shifts, and sickness absence. For each of the 7,652 included employees, work schedules and sickness absence days during 2005 to 2009 were obtained. Sickness absence outcome measures were long-term sickness absence (>7 consecutive sickness absence days), and the number of sickness absence episodes during 2009. The associations of exposure to different shift schedule types, and to cumulative night shifts during 2005 to 2008, with the sickness absence outcome measures were determined using logistic and Poisson regression analyses. It was found that employees who changed into a work schedule that included night shifts had an increased risk for long-term sickness absence (>7 days). Exposure to other types of shift schedules did not result in an increased risk for long-term sickness absence, when indicators for both psychosocial and physical work-related factors were taken into account. In addition, no significant association between exposure to night shifts and long-term sickness absence was found. Compared to day workers, shift work employees showed a lower risk for more sickness absence episodes. Subgroup analyses did show that employees who were single and employees without children had an increased risk for long-term sickness absence when their shift schedule was changed and when they worked in a two-shift schedule. Among other, the results of this study imply that work schedule changes can be associated with more sickness absence, possibly induced by adjustment problems of the employee.

In **Chapter 5**, the association between cumulative exposure to flight types and sickness absence among both cockpit and cabin crew members was described. The study population consisted of 8,228 flight crew members from the MORE cohort. For each employee, all flight schedules and sickness absence days from 2005 to 2009 were obtained. The flights involved in the schedules were classified into night flights, and short-, medium-, and long-haul flights. The associa-

tions between the cumulative exposure to the flight types during 2005 to 2008 and sickness absence episodes of more than seven days in 2009 were determined using univariate and multivariate logistic regression analyses. We found that cumulative exposure to the different flight types was not independently associated with sickness absence when previous sickness absence was taken into account. The results imply that flight type exposure can not explain sickness absence in flight members. To prevent future sickness absence, strategies targeted at flight crew members with a history of high sickness absence may be effective.

Chapter 6 described a study in which the association between cumulative flight schedule exposure and occupational accidents among cabin crew members was analyzed. The study population consisted of 6,311 cabin crew members. For each employee, all flight schedules from 2005 to 2008, and registered occupational accidents in 2009, were collected. The association between the cumulative exposure to different flight types and the occurrence of occupational accidents was determined using logistic regression analyses. It was found that female cabin crew members reported significantly more occupational accidents than their male colleagues, and that with more exposure to short-haul flights, cabin crew members had a higher risk for occupational accidents. On the other hand, more exposure to long-haul flights was associated with a reduced risk for experiencing an occupational accident. The increased risk as a result of short-haul schedules may be caused by the specific characteristics of short-haul flights, and future research should focus on possible underlying mechanisms.

The third section of this thesis focused on the development and evaluation of a mobile health intervention (MORE Energy), aiming to reduce fatigue and improve health of airline pilots. **Chapter 7** described the development of the intervention that consisted of tailored advice on exposure to (day)light, sleep, physical activity, and nutrition. It was decided to provide the MORE Energy intervention through a mobile application, supported by a website, as a result of focus group interviews with a representative sample of pilots, and interviews with key management stakeholders. The advice that aimed to reduce fatigue and circadian disruption as much as possible was evidence-based, and discussed with experts in the field of chronobiology, physical activity, and nutrition. In addition, the advice was tailored to flight schedules and personal characteristics. Personal characteristics that were used to tailor the advice were job title (captain, first officer, second officer) and chronotype (morning vs. evening type). Flight schedule characteristics that were used included haul type (short-haul vs. long-haul), flight direction (neutral, eastward, westward), departure time (morning, afternoon, evening/night), arrival time (morning, day, night), return time (morning, afternoon, evening/night), and the number of time zones crossed (<4 vs. ≥4). The intervention group participants were advised to either hold on to the home based time, or to adjust to the local time, depending on the length of the layover (<48 hours vs. >48 hours). The MORE Energy app enabled users to switch manually between the advised time (local or home-based), depending on their personal preference and situation.

Chapter 8 presented the process evaluation of the intervention. This evaluation was performed to get more insight in barriers and facilitators, strengths and weaknesses of the implementation of the MORE Energy intervention, and to facilitate the interpretation of the results of the effect study. The outcomes that were determined were reach, dose delivered, compliance, fidelity, satisfaction, barriers and facilitators, and adherence. The evaluation showed that the intervention was largely implemented as intended, and that it was well received. Of the participants, only 19% never used any advice on either the app or the website. Yet, the compliance during the whole intervention period was low; only 17% of the intervention group participants consulted the advices for more than four weeks. The appreciation of the intervention was moderate, users indicated that the advices were not always easy to follow up in daily life, and that it was difficult to actually change their behaviour. Nevertheless, 78% of the participants indicated that they would recommend the intervention to their colleagues. Moreover, 65% of the users were convinced that the intervention was able to fulfill its purpose; preventing fatigue and improving their health.

In **Chapter 9**, the effects of the randomized controlled trial on health-related behaviour, fatigue, sleep, and health perception among 502 airline pilots were presented. After randomization, the intervention group was given access to the MORE Energy app with tailored advice, and to the website with background information. The control group was directed to a website with standard fatigue-related information. The outcomes were measured through online questionnaires at baseline and at three and six months after baseline. The effectiveness of the intervention was determined using linear and Poisson mixed model analyses. The results showed that the MORE Energy intervention was effective in reducing the primary outcome fatigue and in improving some of the secondary outcomes related to sleep (sleep quality) and health-related behaviour (snacking behaviour and the amount of physical activity). Other outcomes related to health-related behaviour, sleep, and health perception did not show statistically significant improvements. The results of the trial imply that it is possible to effectively support flight crew members who have to cope with irregular working hours and the crossing of time zones by providing tailored advice through an mHealth intervention.

In the General Discussion **(Chapter 10)**, the main findings of this thesis were presented and put in a broader perspective, considering the methodological issues and the findings of previous research. Recommendations for future research and implications for practice were provided as well. Regarding our first objective, we did not find clear overall associations between work schedule characteristics and sickness absence. Our findings emphasized the influence of the health status and a possible altered lifestyle of the employees. In addition, they indicated that adverse health effects and preferences of irregular working hours can differ between (subgroups) of the studied working population. We therefore recommended to include psychosocial and physical work factors, determinants of workers' capacity (individual characteristics, coping strategies, physical and mental fitness, and lifestyle), and factors outside the working situation (work-life balance and social responsibilities) while analyzing the health effects of irregular working hours in

future studies. We think that more structural collaboration between companies, occupational health services, and research institutes could enable such meaningful epidemiological research.

These collaborations make it possible to study more interventions in real life work settings as well. The second aim of this thesis was to develop and evaluate such an intervention, aimed at reducing fatigue, and improving health of airline pilots. The results of the randomized controlled trial showed that a mobile application providing tailored advice could reduce fatigue, and improve health-related behaviour and sleep quality. We therefore recommended airline companies to try to optimize the work schedules, improve the working situation, and to increase the workers' capacity of both flight crew members and ground staff employees. The latter could be possible through implementing interventions similar to MORE Energy, providing scientifically-based, tailored advice about exposure to light, sleep, nutrition, and physical activity. Since the detrimental health-effects of prolonged exposure to irregular working hours concern employees outside the airline industry just as well, these kinds of target population-specific interventions might also be beneficial for working populations in other industries.